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MEMO

To: Russ Larson & Distribution

From: Don Eyles

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Subject: P66 Improvements

Russ, here is a short exposition of the work I'm doing on P66 so you'll know how to answer any questions that come up at the SCB.

The main P66 change it is desirable to make is to add an LPD capability to that program. An LPD angle will be computed and displayed (along with forward velocity in whole f/s in R1 of noun 60) which at any moment indicates where the spacecraft will land if mode is then returned from attitude-hold to auto. In effect the commander will "mark", using the mode switch, when the spot he wants passes the LPD angle. This idea originated with John Young.

Now the first obvious error in this system stems from the granularity in time with which the "mark" is acted upon. Normally, in LUMINARY and early ZERLINAs (without TLOSS), the P66 horizontal control equation is processed every 2 seconds. In this case the error in the landing site indicated by the "mark" is twice the velocity over the surface. If velocity is 50 f/s the touchdown error may be 100 feet.

Now errors of this magnitude seem to me unacceptable. (Other errors enter from the LPD calculation algorithm, but after a little refinement of this algorithm these should be relatively small.) Thus the alternatives become (1) add a position term to the P66HZ equation, or (2) reduce the granularity in time of acting upon the "mark".

This first is a major effort, and it would be up to the analysis group to come up with the new equation before I could do anything.

The second is workable in ZERLINA (with Variable Period and a new LAD). If the decision whether to process the P66HZ equation is attached to the LAD routine then it can be made every 1/4 second. This does not mean processing P66HZ every 1/4 second. It means having the <u>opportunity</u> to process it that often. Unless a "mark" (switch from attitude-hold to auto) is received P66HZ will function every 8 LADs, or every 2 seconds.

Note that this system presupposes that LAD provides a high-quality velocity vector every 1/4 second. Thus the new LAD is called for.

Note also that if a mark is received just after P66HZ is processed (P66HZ takes just as long in attitude-hold (computing needles) as in auto) then another P66HZ must be called for and two P66HZs will occur 1/4 second apart. Each takes about .3 second so the first will be allowed to finish before the second starts -- which is easily done. Two P66HZs total .6 seconds. In addition within the same 2 second interval two P66RODs must be processed (about .5 second) and of course a full Servicer (1 second). The total exceeds 2 seconds. I would feel very uneasy about subjecting a fixed-period LUMINARY to this kind of dutycycle perturbation. For this reason I doubt P66 LPD can be implemented without Variable Servicer (PCR 1024).

The second aspect of my work on P66 is the long overdue cleaning up of P66ROD. Here too the 1/4 second availability of a good velocity vector is made use of. P66ROD will be processed every TAU except if vertical velocity error exceeds some criterion (tentatively .2 or .25 f/s) in which case P66ROD will be processed every 1/4 second. This means a sort of "squelch" or "deadband". This system combines very rapid ROD response with smoothe throttling in the absense of vertical velocity perturbations (such as ROD clicks). It could probably run well at a TAU lower than the current 1.5 seconds. The computation time for this new P66ROD algorithm will be less than 10% (undoubtedly less still) that of Schulenberg's old algorithm. This, plus the correct engine time constant, permits the dropping of the LAG/TAU term of the P66ROD equation.

To sum up, because it is not thought wise to add a possible .3 seconds to a 2 second period already cramped, P66 LPD is difficult to do in LUMINARY. Possibly, with the new LAD and P66ROD both, P66 LPD could be implemented in LUMINARY without Variable Period. But it is better to regard these four changes as a block update of LM Powered Flight.

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